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ABSTRACT

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THEORETICAL FORMULATION AND EMPIRICAL VALIDATION OF A CONSTRUCT OF CREATIVITY

Thomas Haladyna

Teaching Research

A paper presented at the annual meeting of the American Educational Research Association, Washington, D. C., 1975.

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Abstract

Creativity has been conceptualized as either cognitive or affective, and an analysis of research has indicated that these two approaches are incompatible. In this study, a rapprochement was attempted between these two theoretical approaches using procedures recommended by Cronbach and Meehl (1955). First, a construct of creativity was formulated, then measures were explicated, and finally, a construct validation of these measures was attempted. Results indicated two possible construct reformulations, a one-factor versus a three factor interpretation. To resolve this dilemma, more universally accepted criterion measures appear to have the most promise for accurately identifying creative talent.

CHAPTER I

The Problem

Since the publication of Guilford's "Creativity" in the American Psychologist in 1950, there has been a proliferation of books and articles describing creativity, as well as innumerable descriptive and experimental studies of creative behavior, persons, processes, and products. Despite the considerable attention given to the study of creativity, a number of problems persist, the most serious of which is the confusion surrounding the nature of creativity. Essentially, researchers have conceptualized creativity as either cognitive or affective.

Cognitive Approaches to Creativity

Although mental testing had earlier significant influences on creativity research, the work of Thurstone (1939) was a major contributor to the development and use of tests of creative thinking. The factor analytic work of French (1951) and later the extensive theory development of Guilford (1967) represent most of the history of the tests of creative thinking. Currently, at least three major sets of cognitive tests of creative thinking exist: (a) Guilford's tests of creative thinking (divergent production); Mednick's Remote Associates Test (1962); and Torrance's Minnesota Tests of Creative Thinking. Despite widespread criticism (MacKinnon, 1962; Wallach, 1968; Ginsberg & Whittemore, 1968), these tests of creative thinking, while lacking construct validity, have found widespread acceptance and use. Probably this acceptance can be attributed to the considerable theoretical and empirical work done by Guilford.

Numerous studies have tried to link creative thinking measures with other indicants of creativity. Some of these measures and studies were: (a) nominations of ratings, Torrance (1962); Piers, Daniels, and Quackenbush (1960);

Klausmeier and Weisner (1964); (b) creative production or achievements, MacKinnon (1961), Jacobsen and Asher (1963); (c) creative performance, Brittain and Beittel (1960); and (d) originality, Barron (1955, 1957). The results of these studies, which dealt with a small number of variables, indicate a general lack of empirical relationship between these measures and tests of creative thinking. In studies by McDermid (1965) and Merrifield, Gardner, & Cox (1964), low correlations were observed in correlations between creativity measures and tests of creativity. With few exceptions, then, tests of creative thinking have generally been found to be empirically unrelated to other measures of creativity.

Non-Cognitive Approaches to Creativity

There are at least two major foci in research on creativity where mainly non-cognitive measures are employed: the work of Barron and MacKinnon, and the work of Cattell and associates. The earliest studies of Barron (1953a, 1953b) were concerned with originality; while in later studies, originality was hypothesized as a measure of creativity (Barron, 1963, 1969). Barron describes a highly creative person as independent, original, self-sufficient, determined, efficient, preferring complexity, patient, esthetically inclined, and tolerant of ambiguity.

MacKinnon's major interest has been the continuing study of architects. Employing rating scales, MacKinnon used intensive and extensive methods for collecting data which primarily included measures of personality traits and interests. MacKinnon's findings essentially concur with those of Barron. One area where the studies of Barron and MacKinnon have been especially productive has been the relation of interests to creativity. Using the Strong Vocational Interest Blank, a number of differences have been observed between persons judged to be high and low creative. Studies by Dauw (1966), Cicerelli (1966), and Mednick (1962) have confirmed the findings of Barron (1955, 1957), MacKinnon (1962), and Hall and MacKinnon (1969). To summarize

these findings, highly creative persons were found to have interests similar to those of architects, journalists, lawyers, authors, editors, psychologists, and musicians; low creative persons showed interests similar to those of office managers, bankers, science teachers, and farmers. The higher creative persons were also found to possess a greater number of occupational preferences than those less creative persons. In general, however, the studies of Barron and MacKinnon are difficult to synthesize into useful information. Both tend to be anecdotal, to omit data, and to speculate considerably. Despite these criticisms, the findings of Barron and MacKinnon have been confirmed by many studies where similar non-cognitive measures of creativity have been used.

The parallel work of Cattell and associates, mostly at the Institute for Personality and Ability Testing, have yielded many interesting findings. In many of these studies, the 16 PF Questionnaire, developed by Cattell, has been used to correlate each of the 16 personality factors with other measures of creativity. The general results of studies by Drevdahl (undated), Drevdahl (1956), Drevdahl and Cattell (1958), Cattell and Drevdahl (1955), and Cross, Cattell, and Butcher (1967) can be summarized thus:

Highly creative persons can be typified as reserved (Factor A), emotionally stable (Factor C), assertive (Factor E), venturesome (factor H), tenderminded (Factor I), trusting (Factor L), imaginative (Factor M), placid (Factor O), experimenting (Factor Q_1), and self-sufficient (Factor Q_2).

To conclude, despite some criticisms of methodology, the findings in the area of non-cognitive measures of creativity have been quite useful. Dellas and Gaier (1970) concluded in their exhaustive review of creativity that a common pattern of personality traits for highly creative persons exists. This pattern appears to be focused on the general traits of high motivation, sense of humor, reserve in interpersonal relations, emotional sensitivity, and radicalism.

Relationships Between Cognitive and Non-Cognitive Measures of Creativity

An increasing number of researchers have attempted to examine the relationship between cognitive and non-cognitive measures of creativity, meeting with abject failure. McGuire, Hindsman, King, and Jennings (1961) reported the results of the factor analysis of a multitude of measures which included Guilford-type creativity measures and the Cattell scales. Independent factors of creative thinking and personality were identified. Similar factors were detected through the factor analysis of similar data by Fanani (1964) and Getzels and Czikszentmihalyi (1964). In studies of a strictly correlational nature, a complete lack of association was reported between measures of creative thinking and the 16 PF scales (Barron, 1955; Reid, King, and Wickwire, 1959; Ornmacht, 1967). Thus, whether the analysis of data was bivariate or multivariate, clearly no relationship was detected between cognitive and non-cognitive measures of creativity.

The Measurement Problem

Up to this point, the discussion has dealt primarily with how creativity is conceptualized and some validity problems. A more serious issue is the directness or indirectness of the underlying measuring process.

Direct measures are clear-cut, operational definitions of a trait. They require the concurrence of scientists who study or work with the trait, and such agreement has not existed in the study of creativity. One approach to directly measuring creativity is the product assessment method. One variety, described by Jackson and Messick (1965), is an admittedly loose conceptualization but very promising. Unfortunately, their approach has been untested. The second form of operational definitions of creativity includes judgments of quality and the tabulation of the quantity of scholastic achievements (Holland, 1961; Skager, Schultz, & Klein, 1965), and peer nominations (MacKinnon, 1962, Barron, 1963). The limitations of such operational definitions are quite serious. First, there are far too

many; this abundance of definitions makes the task of measuring creativity more, rather than less, complex. Second and more important, the various operational definitions are conceptually and empirically unrelated. For example, Taylor, Smith, and Ghiselin (1959) found that most direct measures of creativity possessed low intercorrelations. For these reasons, the direct measurement of creativity has been less than useful.

Cronbach and Meehl (1955) have pointed out that when researchers lack useful criterion measures of a trait, they are compelled to study the construct validity of measures of that trait. Such is the case in the study and measurement of creativity. Construct validity requires essentially three steps: (a) formulation of the construct in purely abstract terms; (b) explication of the construct, the connecting of abstract terms to measures of the traits; and (c) the validation of the measures of the construct. Implicit in the formulation and validation of the construct is the making of predictions regarding the relatedness of the measures of the behavior represented by the measures. Further, any construct represents the results of a logical analysis of behavior which attempts to find empirical referents that can be integrated and mapped into a nomological network. Ordinarily, the network is constituted from various sources or methods, and the rules of correspondence tie the abstract construct to observable behavior. The transformation of vague and abstract terms to empirical determinants is what Carnap (1950) called "explication." The testing of inferred or predicted relationships among abstract terms is referred to as "construct validation." Thus the three steps can be summarized simply as formulation, explication, and validation.

The conclusion drawn upon an exhaustive review of the literature of creativity and an analysis of approaches to measurement of creativity is that a useful construct of creativity does not exist and no measures of

creativity possess construct validity.

The Present Investigation

The primary purposes of this study were to formulate a useful construct of creativity and to seek empirical validation of the construct. The procedures used to formulate the construct, the construct itself, and some predictions concerning the interrelatedness of the explicated measures are presented in the next chapter, while the empirical method is presented in ChapterIII, and the empirical results and discussion appear in Chapter IV.

A secondary but very practical purpose of this study was to determine whether or not two eventualities might explain the previously observed lack of relationship, as reported in other studies, between cognitive and non-cognitive measures of creativity. The first possibility is that the relationships have been assumed to be linear when in fact they might be curvilinear. Thus the magnitude of the relationships have been underestimated through the use of a linear correlation, the product-moment coefficient. Both MacKinnon (1961) and Guilford (1965) have implied that relationships between cognitive and non-cognitive measures may be curvilinear, and Digman (1967) as well as MacKinnon and Guilford have suggested several possible explanations for non-linear regression. First, a regression might be truly curvilinear, as in the case of the relationship between age and running speed for 100 yards. Second, relationships of variables from different domains (i.e. cognitive and non-cognitive) may be often curvilinear due to the underlying complex relationship or interaction of cognitive and non-cognitive traits . Third, the non-normality of one or both distributions may yield curvilinear regressions for any bivariate relationship. Fourth, scale aberrations (due to ceiling or floor effects), sample distortions, or disturbances or irregularities in the administration of instruments may create curvilinear regressions. The last three possibilities may be viewed as related to the third, except in instances where non-normality is not a function of the

scaling problems but rather true non-normality.

The second eventuality might be the failure of researchers in the past to correct for the unreliability of measurements. If so, then the true relations among cognitive and non-cognitive measures of creativity may have been obscured. Correction for attenuation permits the investigator to estimate the relationships among the variables given error-free measurement. The importance of correction for attenuation is that it offers information about the true nature of the relationship or the potential correlation if one or both scales had improved reliability. Correction for attenuation is especially dramatically increased when reliability estimates are extremely low. Thus any correction procedure may differentially affect the interrelations among any set of variables.

CHAPTER II

Theoretical Formulation

Procedures for the Formulation

It was concluded that the lack of agreement of researchers as to an adequate and useful operational definition of creativity has led to the study of the construct validity of measures of creativity. This necessitates the formulation of a construct of creativity. The development of any construct requires a formulation in purely abstract terms, the explication of these abstract terms, and the validation of the explicated measures.

The logic of measuring a construct is inferential. In the formulation, purely abstract terms, as shown in Figure 1, are hypothesized; and horizontal relations among these terms are postulated. In the explication, a measure is identified which represents each of the traits described in abstract terms. The relationships between abstract characteristics and explicated measures are depicted as vertical. Associations among explicated measures are also illustrated as horizontal relationships, and these associations are used to make inferences about the relationships among the abstract analogues. Referring again to Figure 1, interrelationships among abstract terms A, B, and C, are represented at the concrete level by intercorrelations among A', B', and C'. The intercorrelations are used to confirm or reject the hypothesized relationships among terms presented at the abstract level.

The formulation of a construct and the empirical validation of measures of that construct may represent a continuous project requiring a considerable investment of time and energy. At the early stage in the development of a construct such as the one presented in this chapter, the organization must be loose and flexible to permit modification if required by subsequent empirical findings.

The Construct

Most of the sources for the formulation of the construct of creativity

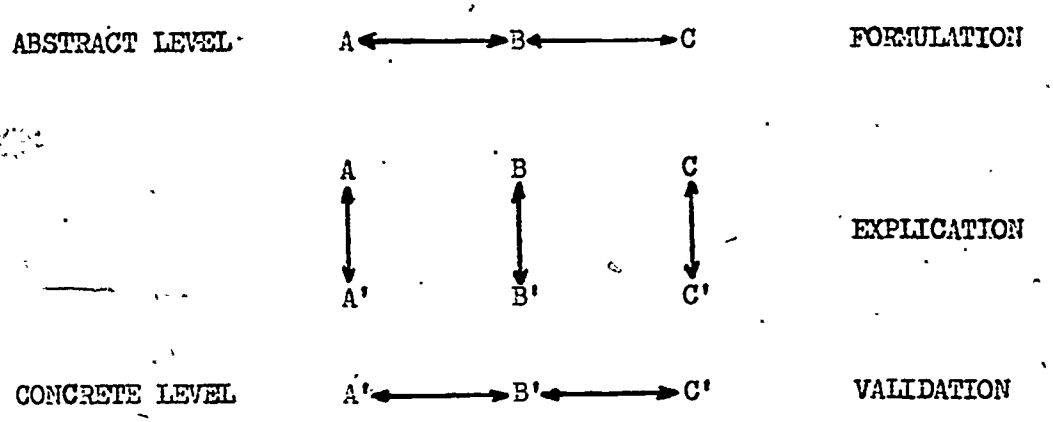


Fig. 1. An illustration of the three stages in the development of evidence for construct validity.

have already been discussed. The construct to be presented here is an attempted rapprochement of two different theoretical positions: (a) Guilford's description of creative behavior which has been explicated with cognitive measures of creative thinking; and (b) Cattell's conceptualization of creativity which has been essentially non-cognitive, and is based on his 16 Personality Factor descriptions of the characteristics of highly creative persons.

Although creativity is considered as a basically cognitive process, Cattell has taken the position that many non-cognitive traits are related to it. Furthermore, previous factor analytic studies (e.g. McGuire et al., 1961) have led to the conclusion that more than one factor is involved in any abstract description of creativity. Thus, it is predicted that for the construct presented here, correlations between most cognitive traits should be statistically significant and at least of moderate magnitudes (between .30 to .50) to possess practical significance.

The organization of the construct developed here is presented in outline form in Table 1. The abstract traits involved in the construct are presented in the left half of the table, and concrete measures relating to some of these traits are listed in the right half. The list of traits and measures describing the construct includes both cognitive and non-cognitive characteristics. All of the traits listed in Table 1 have been either theoretically or empirically related to creativity in the literature, and the following discussion will assume that they all form part of the present construct.

Cognitive traits. The highly creative person is characterized by a number of traits, some of which may be descriptive of the problem solving or creative process and some of which are descriptive of the creative response, product, or solution. The former will be called "process traits" and the

Table 1

An Outline of the Formulated Construct of Creativity

Cognitive Traits:

1. Process Traits
   a. preference for difficult and complex ideas
   b. independence
   c. flexibility
   d. skepticism
   e. tolerance of ambiguity
2. Response Traits
   a. originality
   b. relevance
   c. quality
   d. abundancy

Tests of:

1. ideational fluency
2. originality
3. semantic redefinition
4. figural adaptive flexibility

Non-Cognitive Traits:

1. high motivational state
2. interests in common with "creative" professions
3. sense of humor
4. reserve with people
5. emotional sensitivity
6. radicalism

Measures of the 16 PF Bipolar Traits:

A: Reserved vs. Outgoing

E: Humble vs. Assertive

I: Tough vs. Tenderminded

M: Prudent vs. Imaginative

N: Forthright vs. Shrewd

Q_1: Conservative vs. Experimenting

Q_2: Group Dependent vs. Self-Sufficient

Kuder Interest Scales:

positively related	negatively related
1. journalist	1. high school math teacher
2. news editor	2. accountant
3. interior decorator	3. county agricultural agent
4. architect	4. bank cashier
	5. forester

latter "response traits." A response trait may be a description of a product or invention (e.g., a painting, poem, film, telephone) or it may be a description of a solution to a problem.

The traits associated with the creative process are: (a) a preference for becoming involved in problem solving which is usually complex and difficult; (b) independence and freedom in thinking, coupled with the tendencies to be intuitive, speculative, and risktaking, impulsive, and even visionary; (c) a flexibility in thinking which enables one to generalize, redefine, or transform familiar elements into a new conceptual framework, (d) an avowed skepticism, including the tendencies to be critical, curious, and questioning; and (e) a tolerance of ambiguity.

The creative response traits include (a) originality, (b) relevance, (c) quality, and (d) abundancy. Originality concerns the rarity of correct responses compared with responses typically observed when attempting to solve a problem. Relevance concerns the usefulness of the response to a particular situation. (It is this characteristic of the response, incidentally, that may separate the highly creative person from the psychotic person.) Quality refers to what Jackson and Messick have described as the "world's response" to the creative person. If the creative response is a solution, it must not only be original and relevant, but superior to other solutions as well. If the response is an artistic or scientific one, quality is determined by the favorable reactions of those who view and judge the response. It is noteworthy, though unfortunate, that the essence of quality is not frequently appreciated by various creators' contemporaries (e.g. Galileo's observations of planetary movements, and the paintings of many early impressionists). The last of the four characteristics of the creative response is abundancy, the tendency for highly creative persons to produce many responses which usually possess the characteristics of originality, relevance, and high quality. One aspect of the trait of abundancy is the tendency for the highly creative person to

produce an abundance of responses without a good deal of effort.

Non-cognitive traits. As noted in Table 1, at least six major classes of non-cognitive traits related to the construct of creativity can be identified:

1. The high motivational state is an omnibus term which includes a host of related traits. First, the highly creative person appears to be a good self-starter who is easily motivated. Because of his spirited nature, he may disagree vigorously and appear very argumentative. Furthermore, the high motivational state is marked by aggressive, tenacious, and determined behavior in which a general impression of a self-confident, competitive, and emotionally healthy person is exuded. Getzels and Jackson (1962) have indicated that the highly creative person is physically healthy as well.

2. It has been demonstrated empirically that highly creative persons have interests which are common to certain occupations. In studies where high and low creative persons were identified based on various measures, the interests of highly creative persons were found to be in common with the interests of artists, playwrights, musicians, writers, and researchers. Conversely, interests of low creative persons were found to be in common with those of bankers, accountants, mathematicians, and office workers.

3. A great sense of humor is very typical of highly creative persons, and this is well described in Arthur Koestler's book, The Act of Creation. This sense of humor is empirically documented in Getzels and Jackson's (1962) study. Related to a good sense of humor is a general optimistic outlook toward life. (It is worth noting that the empirical description of the highly creative person as humorous and playful does not correspond to the popular notion that such persons are brooding and tormented.)

4. Even though the highly creative person can be characterized as a humorous,

well-adjusted, and highly motivated person, he is also described as a person who tends to be reserved, withdrawn, and quiescent when in the presence of others, especially strangers. Timidity and introversion do not necessarily conflict with the traits described under the general term "high motivational state." On the one hand, the assertiveness and high motivational state refer to the way a highly creative person approaches the creative process; on the other hand, shyness and reserve refer to interpersonal relations. By focusing attention on the process of creation above other considerations, the highly creative person may find little time for "socializing."

5. Emotional sensitivity refers to a general awareness or perspicacity not observed often in most persons. The highly creative person is also seen as open, frank, sincere, sensitive to beauty, aesthetic, self-aware, affectionate, and receptive to the ideas of others. Thus this constellation of traits refers to the emotional composition of the highly creative person.

6. The last of the non-cognitive traits is radicalism, which is exemplified by eccentricity, distinctiveness, and non-conformity. In general, the highly creative person is considered a malcontent of sorts, who willingly disturbs the status quo.

Concrete cognitive measures. Up to this point, the terms used to describe the creative person's cognitive and non-cognitive characteristics have been largely devoid of empirical content. In the process of construct explication, it is necessary to identify specific measures which may adequately reflect the various dimensions of these abstract terms.

In the area of cognitive measures of creativity, the concepts underlying four tests which are frequently associated with Guilford's description of creative thinking can be considered as corresponding to certain of the cognitive abstract terms in Table 2. The first test, ideational fluency, purportedly measures the ability to call up ideas and is representative of the

Table 2

Assumed Correspondence Between Cognitive Abstract Traits and Various Concrete Measures of Cognitive Characteristics

Abstract Trait	Corresponding Concrete Measure
Abundance of responses	Test of ideational fluency
Originality	Test of originality
Flexibility	Test of semantic redefinition Test of figural adaptive flexibility

response trait abundancy.

The measure of originality is quite directly representative of the response trait originality. However, it must be noted that in Barron's study (1954), one measure of originality was not necessarily highly correlated with other measures of originality.

The test of semantic redefinition purportedly measures the ability to shift or transform familiar elements into something new or unusual; thus it appears to be related to the process trait of flexibility. Since this test requires unusual, yet relevant, responses to problem situations and a willingness to become involved, independence of judgment and a questioning attitude may also prove to be useful analogues at the abstract level. And finally, the test of figural adaptive flexibility is also related to the process trait of flexibility. Table 2 represents a summary of those cognitive traits in the present construct which these Guilford tests appear to measure.

Concrete non-cognitive measures. Sixteen different non-cognitive measures can be considered to represent the six non-cognitive characteristics of highly creative persons. Seven of these measures were taken from Cattell's 16 PF, and nine were taken from the Kuder Occupational Interest Inventory, Form D. The measures corresponding to the abstract non-cognitive characteristics are presented in Table 3.

The process for determining which of a large number of non-cognitive traits best reflects creativity was primarily subjective. First, a list was composed of those traits which were either hypothesized or observed to be related to creativity. Many of these traits were those reported in previously cited studies of Cattell, Drevdahl, Barron, and MacKinnon. Then, the list of over 100 traits was "conceptually factor analyzed." The results were the six traits that appear in Table 3.

Factor E (Humble vs. Assertive) from the 16 PF was hypothesized as representing the abstract trait of "high motivational state." Those scoring

Table 3

Assumed Correspondence Between Non-Cognitive Abstract Traits and Various Concrete Measures of Non-Cognitive Characteristics

Abstract Traits	Corresponding Concrete Measures
High motivational state	Factor E: Humble (-) vs. Assertive (+) positive relation
Interests in common with highly creative occupations	Kuder Scales: 1. Journalists-positive relation 2. News editor-positive relation 3. Interior decorator-positive relation 4. Architect-positive relation 5. High school math teacher-negative relation 6. Bank Cashier-negative relation 7. Accountant-negative relation 8. County agricultural agent-negative relation 9. Forester-negative relation
Sense of humor	Factor M: Prudent (-) vs. Imaginative (+) positive relation
Reserve with people	Factor A: Reserved (-) vs. Outgoing (+) negative relation
Emotional sensitivity	Factor I: Tough (-) vs. Tenderminded (+) positive relation Factor N: Forthright (-) vs. Shrewd (+) negative relation Factor M: Prudent (-) vs. Imaginative (+) positive relation
Radicalism	Factor M: Prudent (-) vs. Imaginative (+) positive relation Factor Q_1: Conservative (-) vs. Experimenting (+) positive relation Factor Q_2: Group Dependent (-) vs. Self-Sufficient (+) positive relation

high on Factor E are purportedly headstrong and independent minded, both being characteristic of the high motivational state.

Nine scales from the Kuder were hypothesized as related to the abstract trait "interests." As indicated in Table 3, five of the scales were considered to indicate high creativity, while the remaining four were considered to indicate low creativity.

Factor M (Prudent vs. Imaginative) appeared reflective of the trait of sense of humor, and Factor A (Reserved vs. Outgoing) appeared to be related to the trait of reserve in interpersonal relationships

For the trait emotional sensitivity, a number of Factors (I, H, and N) were hypothesized as descriptive. Those who score high on Factor I (Tough vs. Tenderminded) are described as emotionally sensitive and aware, while those who score high on Factor M (Prudent vs. Imaginative) are said to be more fanciful and artistic. Factor N (Forthright vs. Shrewd) was hypothesized to be an inverse measure of creativity because the low end of the scale reflects the traits of honesty and naivete. The general depiction of the factor of emotional sensitivity is a person who is sensitive and honest about his feelings.

The abstract trait of radicalism appears best represented by a group of factors (M, Q_1, and Q_2). Persons scoring high on these scales are described as unconventional, experimenting, and independent, and thus they are more like highly creative persons.

Summary and Questions for Empirical Validation

In this chapter, a construct of creativity was presented and explicated primarily using scales from Guilford's cognitive tests and Cattell's 16 PF Questionnaire and secondarily from Kuder scales. As a result of the discussion of this chapter and the preceding one, the following questions were asked as the part of the empirical validation of the construct:

1. Is there more than a chance number of non-linear correlations

between cognitive and non-cognitive measures of the construct?

2. How do deviations from normality affect the frequency of non-linear regressions?

3. Is there a greater proportion of non-linear regressions in relations between cognitive and non-cognitive variables due to an underlying and implicit complexity of relationship?

4. After correction for curvilinearity and attenuation, are the correlations between cognitive and non-cognitive measures of the construct sufficiently high (above .30) to justify the conclusion that each variable measures creativity?

5. Does a factor analysis of the corrected correlation matrix reveal sufficient convergent validity for the measures of creativity across domains and discriminant validity for the measures which were hypothesized as related or unrelated to creativity?

CHAPTER III

Method

Empirical Design

First, the frequency of non-linear regressions was determined. Some factors which affect the occurence of non-linear regressions might be (a) the non-normality of the distributions of one or both variables, (b) true curvilinearity resulting from the inherent complex relationship between cognitive and non-cognitive variables, and (c) scale distortions due to ceiling or floor effects; inappropriate sampling; or improper administration or scoring of tests. Next, a matrix of linear correlation coefficients was compared to a corresponding matrix of correlations where correction was made for curvilinear regression and attenuation.

The next phase of the empirical aspect of this study dealt with the construct validation of the measures hypothesized as indicators of creativity and directly follows the procedures previously discussed; i.e. formulation, explication, and validation. In the validation process, the hypothesized interrelationships were tested by examining the observed relations between and among all variables, both those hypothesized as related and unrelated to creativity.

Toward this end, Campbell and Fiske (1959) have suggested a systematic way of studying the construct validity of a set of measures which are said to represent a construct. Each test is considered to be a construct-method unit, and portions of the total variance of all test scores can be attributed to a particular construct and a particular method. If correlations among independent measures of the same construct are high, convergent validity for these measures is indicated. Discriminant validity is the establishment of the independence of conceptually unrelated constructs even when the same general measurement technique is used. As shown in Figure 2, six construct-method units exist in the present study. To demonstrate convergent

			B Constructs	
			Creativity 1	Non-Creativity 2
A Methods	Cognitive Tests	1	a_1b_1	a_1b_2
	Non-Cognitive Tests 16 PF	2	a_2b_1	a_2b_2
	Non-Cognitive Tests Kuder	3	a_3b_1	a_3b_2

Fig.2. Six major construct-method units.

validity for the hypothesized measures of creativity, high correlations are required among the measures of cells a_1b_1, a_2b_1, and a_3b_1. Discriminant validity can be demonstrated if low correlations are observed between measures of the following pairs of cells: a_1b_1 and a_1b_2; a_1b_1 and a_2b_2; a_1b_1 and a_3b_2; a_2b_1 and a_2b_2; a_2b_1 and a_3b_2; a_3b_1 and a_1b_2; a_3b_1 and a_2b_2; and a_3b_1 and a_3b_2. In general, discriminant validity is indicated by low correlations between columns and high correlations within columns. When the intercorrelations among the scales of a particular instrument are higher than correlations between that instrument's scales and other measures of the same trait, instrument bias is suggested. In terms of Figure 2, instrument bias is indicated by extremely high correlations within rows.

More recently, Boruch, Larkin, Wolins, and McKinney (1970) have suggested a better way to utilize the logic of Campbell and Fiske's procedures. These authors suggest that a factor analysis of the data would help summarize the evidence for the convergent and discriminant validity of the measures, and, accordingly, their recommendations will be followed in this study. Based on a factor analysis of measures of creativity and measures of other constructs, the variance might be partitioned according to the following sources:

σ^2_t = total variance

σ^2_c = variance attributed to creativity

σ^2_{nc} = variance attributed to other factors not related to creativity

σ^2_i = variance attributed to instrument bias

σ^2_e = error variance

where $\sigma^2_t = \sigma^2_c + \sigma^2_{nc} + \sigma^2_i + \sigma^2_e$.

High factor loadings should then be found on a creativity factor for the hypothesized measures of creativity and low factor loadings on that factor for variables not hypothesized as measures of characteristics

of creativity. Content factors which represent traits not related to creativity have great usefulness in the development of the convergent and discriminant validity for the measures of the study. The greater the number of theseccontent factors, the smaller the error variance. Instrument bias is demonstrated by high factor loadings for scales of a particular instrument.

Population and Sample

The sample used in the present study consisted of 708 students who took an extensive battery of tests between the years 1963 and 1969 and prior to their admittance to a College of Architecture at a large university in the Southwest. Although the sample consisted of architecture students, 99% of which were male, the students were quite similar to other college students in grade point average, American College Test scores, and 16 PF scores. Using .05 as the criterion for testing the differences in means for the sample used in this study and more generalizable samples of college students, 10 of the 22 statistical tests revealed significant differences. However, the extremely large samples created sufficiently small standard errors of difference to magnify small magnitude differences thus permitting statistical significance. Most ACT score differences were less than one, the one exception being a three point difference in mathematics in favor of the general college population. The differences in magnitudes between the two groups for 16 PF scores ranged from .3 to 1.4, all small magnitudes considering the scale of the 16 PF. These results were accepted as evidence of the equivalence of the two samples. So despite the limitations of the sample employed, the architecture students did resemble the general college population in a number of cognitive and affective measures.

Instrumentation

Tests administered to the architecture students included (a) Guil-

ford tests of creative, spatial, and perceptual abilities, (b) the 16 PF Questionnaire, and (c) the Kuder Occupational Interest Inventory, Form D.

The tests of special cognitive abilities were obtained from various sources. Reliability estimates and some evidence for empirical and construct validity can be found in Thurstone (1939) and Guilford and Hoepfner (1966). The reliability estimates for all measures used in the study are presented in Appendix A. As shown there, reliability estimates ranged from .67 to .95 with a median of .81. The validity of the creative thinking tests as measures of mental abilities is essentially construct, and the tests have been extensively studied by Guilford (1967).

Also reported in Appendix A are the internal consistency estimates of the 16 PF scales. As shown there, these estimates vary greatly, ranging from .35 to .85 with a median of .66. The validity of the 16PF is primarily based on its content, resulting from many factor analytic studies of the 16 PF data.

The Kuder scales, on the other hand, evidence consistently high test-retest reliability estimates, and the validity of the Kuder scales appears to have been empirically derived. However, seldom have Kuder scales been significantly related to practical performance criteria (Buros, 1965).

Data Analysis

First, intercorrelations among all variables of the study were computed using both the Pearson product-moment correlation (PPMI) and the correlation ratio (eta). Corresponding correlation coefficients were compared using an F-test at the 10 per cent level of significance. The 10 per cent criterion was selected to maximize the power of the statistical at the expense of committing more Type I errors. (A thorough discussion of the use of eta coefficients including pitfalls and methodology can be

found in Haladyna, 1973.)

To investigate the possibility that curvilinear regressions exist in the relationships between cognitive and non-cognitive variables, the proportions of statistically significant curvilinear correlations were compared for the categories of correlations (a) among cognitive measures of creativity, (b) among non-cognitive measures of creativity, and (c) between these cognitive and non-cognitive measures. A test for the differences between proportions was done for all possible pairs.

To determine the effects of non-normality of one or both distributions, first all variables were tested for skewness and kurtosis and proportions of non-linear regressions computed for the categories of correlations (a) among normally distributed variables, (b) among non-normally distributed variables, and (c) between normally and non-normally distributed variables. Again, the test of differences between the proportions of all possible pairs was made.

To determine if corrections for curvilinear regression and attenuation significantly improved relationships between cognitive and non-cognitive measures of creativity, two correlation matrices were constructed. The first consisted of PPM coefficients, and the second was composed of correlations which were corrected for curvilinear regressions and attenuation. All statistically significant eta coefficients (i.e. when eta was found to be statistically higher than PPM) replaced their corresponding PPM coefficients, and then all coefficients were corrected for attenuation. Thus the magnitudes expressed in the second correlation matrix represented the relationships as they existed under the conditions of the real regression line and error-free measurement.

Since the sample size was quite large, over 700, employing tests of significance did not seem completely appropriate. For example, a correlation of .08 would be statistically significant for a sample size of 700. Instead

of statistical significance, a count was made of the correlations which exceeded .30. The reason for selecting this magnitude as a threshold was that seldom have correlations between cognitive and non-cognitive measures of creativity exceeded .30. Thus, any change in the strength of relationship would indicate an advantage to such correction procedures as well as a discovery of a stronger relationship between these cognitive and non-cognitive variables.

To investigate the possibility of convergent and discriminant validity for the hypothesized measures of creativity, the matrix of correlations, which was corrected for curvilinear regression and unreliability, were factor analyzed using the principal components and varimax procedures. Significant factor loadings were considered to be those exceeding .30.

CHAPTER IV

Results and Discussion

Effects of Curvilinearity

Curvilinearity between cognitive and non-cognitive measures. The greatest proportion of non-linear correlations was observed among non-cognitive variables, as shown in Table 4. This proportion (43%) was significantly greater than each of the proportions of the remaining two categories ($p < .01$). Although not directly related, but of additional interest, are the proportions of non-linear regressions detected for the variables which were hypothesized as unrelated to creativity and for all the variables of the study. In both instances, the highest proportion of statistically significant eta coefficients occurred for the correlations among non-cognitive variables. In fact, the proportions of variables not related to creativity were quite similar to the proportions of variables hypothesized as related to creativity.

Even though the porportions of non-linear regressions observed in the categories of correlations of (a) among cognitive measures and (b) between cognitive and non-cognitive measures were small, these were statistically significantly higher than the proportions that might have occurred by chance. However, employing criteria developed by Haladyna (1973), the bulk of all statistically significant eta coefficients were found to be less useful due to their complex and non-monotonic regression lines as well as the practically small magnitudes of gains in accounted variance (i.e. the difference between r^2 and η^2).

A further result of interest is the breakdown of the proportion of non-linear regressions observed by instrument, shown in Table 5. These results show that the greatest frequency of non-linear regressions occurred in the incorrelations among Kuder scales (75%) and among 16 PF scales (57%). Other categories of correlations had considerably lower proportions of non-

Table 4

Extent of Curvilinearity Among Cognitive, Among Non-Cognitive, and Between Cognitive and Non-Cognitive Measures of Creativity

	Hypothesized Measures of Creativity				Variables Unrelated to Creativity				All Variables of the Study			
	# of tests	# of sig.[1] etas	% of sig. etas	Prob.	# of tests	# of sig. etas	% of sig. etas	Prob.	# of tests	# of sig. etas	% of sig. etas	Prob.
Among Cognitive Measures	6	1	17	>.10	60	13	22	<.05	66	14	21	<.05
Among Non-Cognitive Measures	120	52	43	<.01	510	227	46	<.01	630	279	45	<.01
Between Cognitive and Non-Cognitive Measures	64	11	18	>.10	368	58	15	>.10	432	69	16	<.01
Totals	190	64	34	<.01	938	298	31	<.01	1128	362	32	<.01

[1]The tests are the significance of the difference between the product-moment correlation and the eta coefficient.

Table 5

Extent of Curvilinearity Among and Between 16 PF, Kuder, and Cognitive Measures Hypothesized to be Related to Creativity

	# of tests[1]	# of sig. eta's	% of sig. eta's	prob.
Among 16 PF Measures	21	12	57	<.01
Among Kuder Measures	36	27	75	<.01
Between 16 PF and Kuder Measures	63	13	21	<.05
Between 16 PF and Cognitive Measures	28	7	25	<.05
Between Kuder and Cognitive Measures	36	4	11	>.10
Totals	184	63	34	.01

[1]The tests are the significance of the difference between the product-moment correlation and the eta coefficient.

linear regressions.

Normality of the marginal distributions as a factor for non-linearity. As shown in Appendix A, all variables were classified on the basis of statistical tests for skewness and kurtosis as either normally or non-normally distributed. Proportions of non-linear regressions were observed for the categories of correlations (a) among normally distributed variables, (b) among non-normally distributed variables, and (c) between normally and non-normally distributed variables. As indicated in Table 6, nearly the same proportions were observed for each category. Employing the tests of differences in proportions for each possible pair of categories, no statistical significance was observed. When comparing each proportion with the proportion expected by chance alone, each category was statistically significant.

Joint Effects of Correction for Curvilinearity and Attenuation

Two correlation matrixes are presented in Table 7. The first contains PPM coefficients; the second represents the results of correction for curvilinearity and attenuation. Since correction for attenuation is a direct and inverse function of the product of the two respective reliability estimates, the greatest increases from matrix to matrix occurred where reliability estimates were lowest. With respect to curvilinearity, large magnitude increases ($\eta^2 - r^2$) were infrequent, less than six per cent. Thus it would be expected that the joint effects of correction for curvilinearity and attenuation should be greatest for intercorrelations among the 16 PF scales where reliability estimates were often lower and where a high percentage of regressions were curvilinear. As shown in Table 7, only two of the total 64 correlations between cognitive and non-cognitive measures hypothesized as related to creativity were observed to be above .30 after correction. As anticipated, the greatest increases between before and after correction occurred in the correlations among 16 PF

Table 6

Number of Variables, Total Correlations, Significant Eta Coefficients Percentage of Significant Eta Coefficients, and the Probability of Obtaining that Number or More by Chance Alone[1]

	Number of Variables	Number of Correlations	Number of Sig. Etas	%	Prob.
Intercorrelations Among Normally Distributed Variables	15	105	29	28	<.001
Intercorrelations Among Non-Normally Distributed Variables	33	528	189	36	<.001
Correlations Between Normally & Non-Normally Distributed Variables	--	495	144	29	<.001
Total	48	1128	362	32	<.001

[1]This refers to the probability of getting the indicated number or greater number of eta coefficients significant (at the 10% level) larger than the corresponding product-moment correlation.

Table 7

Correlation Matrix[1] of All Measures Which Were Hypothesized to be Related to Creativity

Shown Before and After Correction for Curvilinearity and Attenuation

Measures of Creativity	1	2	3	4	A	E	I	M	N	Q_1	Q_2	1	2	3	4	5	6	7	8	9
Tests of Creative Thinking:																				
1. Ideational Fluency	(79)	28	11	-06	00	04	02	-04	-01	02	-03	06	05	08	04	-06	-05	-03	03	-03
2. Originality	37	(70)	14	02	09	-02	01	00	-02	07	-12	03	02	12	08	01	-10	00	-02	-08
3. Semantic Redefinition	16	21	(67)	14	-06	03	01	-08	02	05	01	02	00	03	04	-06	-01	-01	-02	-01
4. Figural Adaptive Flexibility	-06	03	29	(80)	-04	02	05	-01	05	04	09	00	-04	-02	04	06	05	04	-05	01
16 PF Scales																				
A (Reserved-Outgoing)	-20	-26	-09	-05	(80)	12	10	04	06	04	-14	19	14	07	-01	-13	08	22	07	-06
E (Humble-Assertive)	06	25	05	-19	26	(65)	09	23	27	25	14	11	01	08	06	-05	-04	03	00	-01
I (Tough-Tenderminded)	02	01	01	06	19	30	(85)	39	02	13	24	18	22	25	19	05	-21	-05	-20	-14
M (Prudent-Imaginative)	21	00	-13	-01	05	45	52	(66)	14	32	34	19	20	24	23	04	-25	-02	-18	-10
N (Forthright-Shrewd)	-01	-05	04	09	29	57	24	51	(35)	28	20	-06	-05	-08	-04	09	13	10	12	05
Q_1 (Conservative-Experimenting)	04	33	09	06	23	44	19	56	75	(50)	23	09	04	12	16	12	-11	09	-07	-03
Q_2 (Group Dep.-Self-Sufficient)	-04	-32	02	13	-20	41	35	58	56	42	(57)	10	09	02	12	11	-14	-02	-16	15
Kuder Scales																				
1. Journalist	07	04	02	00	30	15	27	25	-11	-03	14	(88)	85	38	38	02	-18	29	-04	08
2. News Editor	06	03	00	-04	16	01	24	26	32	06	12	94	(91)	38	37	04	-19	26	-05	03
3. Interior Decorator	09	26	04	-02	08	10	29	31	-14	18	02	43	43	(90)	78	06	-33	26	-14	-20
4. Architect	04	10	05	04	-01	08	29	29	-06	23	16	42	43	85	(92)	29	-28	33	-12	-02
5. H. S. Math Teacher	-07	02	-07	08	-20	20	06	05	16	-18	-16	-24	21	06	35	(90)	16	37	09	07
6. Bank Cashier	-06	-12	-01	03	10	-05	-23	-33	40	-17	-33	39	-35	-44	-44	27	(90)	32	27	18
7. Accountant	-21	-16	-02	05	28	04	12	-03	18	15	-03	46	40	35	43	51	41	(78)	15	14
8. County Agricultural Agent	03	-02	-02	-06	40	-01	-23	-23	22	-11	-28	20	22	-15	26	24	41	29	(88)	29
9. Forester	-19	-24	-01	00	36	-01	-17	-14	09	-04	32	32	24	-30	21	22	26	38	34	(82)

[1] Reliability estimates appear in parentheses, uncorrected correlations appear in the upper diagnoal, and corrected correlations appear in the lower diagonal. All reliability estimates and correlations appear with decimals omitted.

and among Kuder scales. Among 16 PF intercorrelations, only three coefficients exceeded .30 before correction as opposed to 13 after correction. With Kuder scales, intercorrelations above .30 numbered 10 before correction and 22 after correction.

The greatest difference observed from before to after correction occurred in the correlation between Factors N and Q_1. The joint effects produced a correction difference of .47. However, seldom did corrections in the entire correlation matrix exceed .10.

Construct Validity

The first step in the construct validation phase of this study was to subject all variables to a factor analysis thus allowing a breakdown of the sources of variance. The results of the factor analysis revealed the following partitioning of variance:

14% was attributed to three distinct factors related to creativity;

46% was attributed to nine factors not related to creativity;

27% was attributed to instrument biases of the Kuder and the 16 PF;

13% was not accounted for and thus classified as error.

The results of the varimax rotation are presented in Table 8, and it is indicated that 14 factors with eigenvalues greater than 1.00 accounted for 87% of the variance of these data.

Each of the first two factors possesses high factor loadings on scales from a particular instrument, the Kuder and the 16 PF, respectively. Thus, Factor I was termed a Kuder instrument factor, and Factor II was termed a 16 PF instrument factor. In both instances, the scales of each instrument appeared to measure a factor peculiar to that instrument. The third factor, III, loaded highest on the 12 tests of cognitive abilities. This factor appeared to represent one of perceptual cognition and accounted for eight per cent of the variance.

Table 8

Factor Loadings[1] for the Varimax Rotation Analysis of All Variables After Correlations Were Corrected for Curvilinear Regression and Attenuation

(N = 710)

Factor	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Per cent Variance	14	13	8	5	5	6	7	6	4	4	4	4	4	5
Cognitive Measures Hypothesized as Related to Creativity:														
1. Ideational Fluency	03	00	45	-01	15	-06	-05	-01	36	-16	-07	-26	25	-02
2. Originality	09	04	30	-04	-18	06	-04	-03	83	-02	00	-08	00	-09
3. Semantic Redefinition	-04	02	20	-02	-05	-24	-11	-10	-24	28	02	-64	01	-05
4. Figural Adaptive Flexibility	-09	05	31	11	14	-02	12	-07	-14	-10	08	-60	04	10
Non-Cognitive Measures Hypothesized as Related to Creativity: 16 PF Bipolar Scales														
A (Reserved vs. Outgoing)	37	34	-03	-16	-27	20	-15	55	-22	-20	-01	-18	13	-40
E (Humble vs. Assertive)	13	66	01	-07	-14	23	-04	-03	-36	21	17	-15	03	-10
I (Tough vs. Tenderminded)	17	11	-05	-13	12	19	06	03	-04	09	91	-11	03	12
M (Prudent vs. Imaginative)	11	50	11	-18	07	17	-14	13	13	13	43	22	21	39
N (Forthright vs. Shrewd)	01	93	01	15	00	17	-09	-14	-16	22	05	02	15	01
Q_1 (Conservative vs. Experimenting)	-15	65	-03	-06	06	07	16	-08	-39	-08	03	-26	24	34
Q_2 (Group Dependent vs. Self-Suff.)	-03	42	-03	-06	-15	13	02	-06	-12	06	20	-08	10	90

Table 11--Continued

Factor	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Kuder Scales														
1. Journalist	75	-09	04	19	-32	-03	-02	18	-01	14	16	00	44	13
2. News Editor	54	-08	09	-04	-21	-02	09	-06	-09	02	30	03	60	04
3. Interior Decorator	65	-02	09	-62	-15	-12	06	-10	14	-04	21	-04	00	03
4. Architect	52	04	17	-44	-15	-21	35	-18	-02	01	30	00	-01	07
5. High School Math Teacher	12	09	08	28	01	03	51	-68	02	-20	24	17	-23	-20
6. Bank Cashier	25	07	-06	95	-04	-05	-39	-24	-01	-20	-10	-09	-08	-05
7. Accountant	55	10	04	21	-22	-01	12	-49	-14	-22	01	-10	18	-04
8. County Agricultural Agent	21	14	-03	-40	-18	-16	30	-04	-19	-11	-15	07	15	-40
9. Forester	05	08	02	-01	-100	-04	13	-22	-18	-05	-11	02	-01	05
Cognitive Measures Hypothesized as Not Related to Creativity:														
1. Flexibility of Closure	14	-04	68	-14	10	02	10	08	-06	-13	-23	-08	06	14
2. Speed of Closure	03	-05	58	-10	01	-05	-11	-10	07	02	07	-15	13	-01
3. Length Estimation	13	-02	68	-15	-05	-12	03	-06	17	-12	06	18	-01	00
4. Perceptual Speed	11	05	74	-08	-08	-04	05	-04	16	-04	04	06	-02	-02
5. Spatial Orientation	01	03	70	-01	-13	21	-08	07	-11	00	-04	-26	-07	-06
6. Spatial Scanning	-09	02	67	05	-10	00	18	00	-07	19	-02	-32	-01	-05
7. Visualization	-04	-01	56	-04	-07	05	00	-10	10	03	01	-53	-12	03
8. Induction	-06	-09	39	32	01	-01	20	03	22	32	15	-23	-05	01

Table 11--Continued

Factor	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Non-Cognitive Measures Hypothesized as Not Related to Creativity:														
16 PF Bipolar Scales														
B Less vs. More Intelligent	18	34	19	-20	09	11	03	-09	-05	85	10	-10	-01	07
C Affected by Feeling vs. Emotionally Stable	-11	97	-11	01	06	-46	01	-04	-17	03	06	02	05	07
F Sober vs. Happy-Go-Lucky	12	63	-02	00	02	13	-17	00	07	07	21	00	20	-61
G Expedient vs. Conscientious	10	89	-07	-17	01	16	-17	01	-07	-17	-24	-01	03	13
H Shy vs. Venturesome	32	62	-06	-10	-07	29	-04	-11	32	-20	-12	-11	-08	-38
L Trusting vs. Suspicious	-12	30	00	-06	06	34	04	-08	10	-04	-05	-02	79	00
O Placid vs. Apprehensive	01	14	02	-04	06	98	-08	03	-15	-16	-01	09	10	07
Q_3 Casual vs. Controlled	01	91	12	-08	-14	24	-05	-15	-08	-29	11	-10	-26	09
Q_4 Relaxed vs. Tense	-15	16	00	07	-01	92	10	08	21	-11	23	01	16	-01
Kuder Scales														
1. Personnel Manager	88	18	06	-07	-08	-01	12	-07	11	-03	-04	11	-16	03
2. High School Counselor	85	-05	-01	09	33	-03	37	00	07	03	02	-01	-15	-07
3. YMCA Secretary	70	-02	-08	-19	36	08	43	01	10	-17	-05	-07	-10	-20
4. School Superintendent	76	-17	-02	-14	22	-10	32	-22	05	12	-13	-19	-11	-25
5. High School Science Teacher	26	-02	-04	-07	-17	-08	93	-14	06	29	-06	-05	-11	06
6. Lawyer	91	04	08	06	-19	-02	-13	-15	07	16	06	-01	10	-02
7. Retail Clothier	68	23	07	04	31	05	-24	-24	-28	-00	09	05	21	-07
8. Dentist	23	-04	12	-33	11	-05	67	-27	-12	-03	04	02	12	-01
9. Physician	38	-03	02	-04	-10	-07	79	-06	13	-13	10	-01	15	-07
10. Mining & Metallurgical Engineer	25	14	05	-08	-15	-12	23	-84	06	13	05	-16	06	-03
11. Civil Engineer	24	08	-05	14	-20	13	12	-75	-09	04	-33	-20	14	14

Of the remaining 11 factors, only three (Factors IV, IX, and XIV) appear to be related to the construct of creativity. Factor IV was termed "Interests of Low Creative Persons," and the variables and their respective factor loadings were:

tests of inductive reasoning	.32
*interests like bank cashiers	.95
interests like dentists	-.33
*interests like interior decorators	-.62
*interests like county agricultural agents	.40
*interests like architects	-.44

Those variables denoted with an asterisk were hypothesized to measure characteristics related to creativity, and the signs were in agreement with those predicted from the construct. The inclusion of the inductive reasoning test and the dentists scale from the Kuder, two measures which were not hypothesized as unrelated to creativity, were not expected. However, both variables possessed the lowest factor loadings for the "Interests" factor.

"Originality" (Factor IX) was the second factor which was related to the construct. Those variables having loadings above .30 were:

*ideational fluency	.38
*originality	.83
*E (Humble vs. Assertive)	.36
H (Shy vs. Venturesome)	.32
*Q_1 (Conservative vs. Experimenting)	.39

Four of these five variables (as denoted by the asterisk) were hypothesized as related to creativity. The originality factor reflects both cognitive and non-cognitive characteristics of creativity. In the cognitive area both fluency and originality are represented; in the non-cognitive area, the high motivational state and radicalism are represented by E, H, and Q_1.

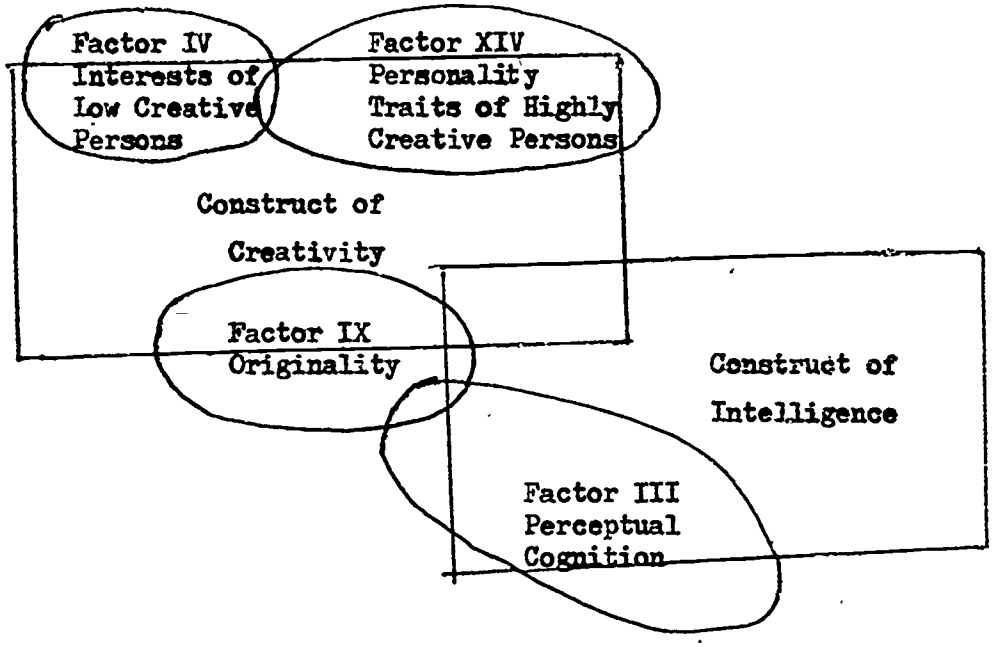
The last of the three factors which appeared to be related to the construct of creativity was Factor XIV, which was labeled "Personality Characteristics of Highly Creative Persons." Those variables which had factor loadings above .30 were:

*interests like county agrucultural agents	-.40
*A (Reserved vs. Outgoing)	-.40
F (Sober vs. Happy-Go-Lucky)	-.60
H (Shy vs. Venturesome)	-.38
*M (Prudent vs. Imaginative)	.39
Q_1 (Conservative vs. Experimenting)	.34
Q_2 (Group Dependent vs. Self-Sufficient)	.90

Although Factor XIV accounted for only a small per cent of the variance, the indication is that the abstract non-cognitive areas of humor, reserve with people, and radicalism are well represented. Although scales F and H were not specifically hypothesized as related to creativity, their inclusion is not incompatible with the abstract descriptions of highly creative persons as socially introverted.

It is apparent from these factor analytic results shown in Table 8 that three empirically unrelated factors are conceptually related to the construct presented earlier. Before conclusions can be drawn regarding the convergent and discriminant validity of the hypothesized measures of creativity, two rivaling interpretations of these data must be presented. The first position is that one factor (IX), Originality, most clearly represents that which has been abstractly described as creativity. The other two factors (IV and XIV) represent descriptions of creativity which have been erroneously related to creativity. The relationships among the three factors (IV, IX, and XIV) and the relationship between each of these factors and the constructs of creativity and intelligence are illustrated in Figure 3. Additionally, the other important factors are depicted in Figure 3 in terms of both conceptual and empirical relationships. In this figure, the constructs of creativity and intelligence are shown to be slightly overlapping, and the factors of perceptual cognition and originality are respectively measures of intelligence and creativity. The instrument bias factors and non-creativity factors are shown as independent of both creativity and intelligence.

The rivaling interpretation, illustrated in Figure 4, is a multi-factor position where all three factors (IV, IX, and XIV) might be accepted

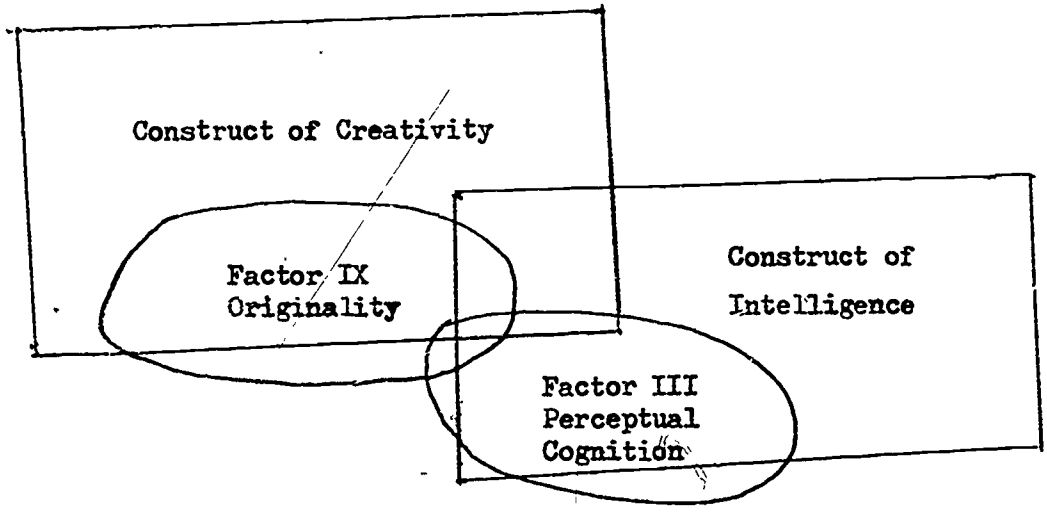


Factor I Instrument Bias of the Kuder

Factor II Instrument Bias of the 16 PF

Empirically Observed Factors		Percentages Accounted for in Factor Analysis
I	Instrument Bias of the Kuder	14
II	Instrument Bias of the 16 PF	13
III	Perceptual Cognition	8
IV	Interests as Related to Creativity	5
IX	Originality as Related to Creativity	4
XIV	Personality Traits as Related to Creativity	5

Fig. 3. Illustration of a multi-factor interpretation of creativity from the results of the factor analysis.



Factor I

Factor II

Factor IV

Factor XIV

	Empirically Observed Factors	Percentages Accounted for in Factor Analysis
I	Instrument Bias of the Kuder	14
II	Instrument Bias of the 16 PF	13
III	Perceptual Cognition	8
IV	Interests Incorrectly Related to Creativity	5
IX	Originality as Related to Creativity	4
XIV	Personality Traits Incorrectly Related to Creativity	5

Fig. . Illustration of a one-factor interpretation of creativity from the results of the factor analysis.

as independent measures of the same construct. Thus, each factor contributes uniquely to the description of creativity.

Chapter V

Conclusions and Implications

Conclusions

Extent of Curvilinearity. On the basis of the findings of this study, there is no good reason to expect, in general, curvilinear relationships between cognitive and non-cognitive variables, whether or not they are hypothesized as related to creativity. There are a sizable number of curvilinear relationships among non-cognitive variables, particularly when the scales are derived from the same instrument (as in the cases of the 16 PF and the Kuder). However, when more rigorous criteria for determining curvilinearity were introduced (Haladyna, 1973), fewer than 6% of the regressions were found to be curvilinear. Despite these few practically significant non-linear regressions, it would seem wise and fruitful to investigate for the possibility of non-linear relations when working with such non-cognitive variables. The results also indicated that the lack of normality of the marginal distributions was not related to the frequency of occurrence of non-linear regressions.

Joint Effects of Correction for Curvilinearity and Attenuation. Making corrections for curvilinearity as well as attenuation did not have a great effect on the correlations between cognitive and non-cognitive variables, regardless of the fact that some were designated as measures related to creativity and some were not so designated. Three factors may have produced these results. First, the initial magnitudes of relationships were so low (often zero) that even substantial corrections would not increase the magnitudes to values above the minimum level of .30 which was previously established as a minimal acceptable level for positive evidence of convergent

and discriminant validity. Second, reliability estimates were relatively high, usually above .70 and thus, the corrections themselves were often small. Finally, only a few non-linear regressions were detected which possessed any sizable differences in magnitude.

Construct Validity. Conclusions regarding the convergent and discriminant validity of the 20 measures which were hypothesized as related to creativity are largely dependent upon which interpretation (one vs. multi-factors) is used. Regardless of the choice, the existence of instrument bias in both the Kuder and the 16 PF instruments was evident. Thus the validity of the scales as independent measures of interests and of personality traits is questionable. Further, the high degree of instrument bias adversely affects the discriminant validity of the scales hypothesized as indicators of creativity.

From a one-factor perspective, both cognitive and non-cognitive variables were significantly related to the originality factor (XIV) which indicates a modest amount of convergent validity for those measures which possessed factor loadings above .30 for Factor IX. From the multi-factor interpretation, the relative instrument-dependent factors of interest (IV) and personality traits (XIV) appear to possess very little convergent validity.

As a result, the construct validity of the 20 measures hypothesized as related to the construct of creativity has not been demonstrated to a large or even modest degree. Instead of a clear-cut confirmation of the construct, the dilemma of rivaling interpretations coupled with the large degree of instrument bias for both the Kuder and the 16 PF prevails unresolved.

Implications

According to Cronbach and Meehl (1955), when the data do not support the existence of the formulated construct, the fault may lie in (a) the procedure used to check the predictions, (b) the measures used to validate the construct, or (c) the construct itself.

Procedures. One problem of this study resided in the use of a single sign to describe a more complex curvilinear regression. The use of a single

algebraic sign reduced the ambiguity of the nature of the relationship at the expense of accuracy. In these instances, the slope of the regression changed several times. The sign was determined by noting the general slope of regression. The magnitude of the eta coefficient in these instances is an index of the closeness of fit in the least squares sense. However, it must be noted that some misclassification occurs when only one sign is used to describe this complex regression. The problem remains to be solved, and it is purely a methodological issue.

With the discovery of numerous instances of curvilinearity in the correlations among non-cognitive variables, the further investigation and application of the eta coefficient in both practical and theoretical studies is strongly suggested. Related to this is the parallel development of techniques for properly utilizing eta coefficients in multivariate techniques such as factor analysis or regression analysis. Once an adequate construct has been validated, factor scores could be generated from factor analysis of measures hypothesized as related or unrelated to creativity. If a useful construct of creativity can be formulated, whether it be one factor or multi-dimensional, the procedure just outlined would provide some logical justification for obtaining a creativity index. Perhaps the recent interest in the use of moderator variables in creativity studies (e.g. Rock, Evans, and Klein, 1969) may bear importantly upon the use of the eta coefficient. If the regression line changes slope several times, then dividing the sample at the change points may improve prediction by the subdivision of the sample. Such subdivisions would serve to clarify the relationships between two variables when using the traditional linear correlation technique.

Although non-linear regression was not observed in the correlations between cognitive and non-cognitive measures in this study, there was a considerably greater proportion of non-linear regressions observed among the intercorrelations of non-cognitive variables. Thus, the joint effect of

correction for curvilinearity and attenuation was greatest for correlations among non-cognitive variables. However, the problem of instrument bias remains a serious one. Instrument-independent scales of the traits of humor, reserve, emotional sensitivity, radicalism, and high motivational state would be most beneficial in studying the personalogical factors thought to be indicators of creative behavior.

Construct. An important outcome of this study is evidence for the need to reformulate the construct of creativity in light of the new information provided in this study. Since the dilemma of two interpretations exists as a result of this study, two reformulations of the construct are suggested. Both are presented in the form of rivaling hypotheses. Any subsequent research along the lines of construct validity of these measures should then be focused on determining which reformulation is most tenable.

The first reformulation, a one-factor approach, is outlined in Table 12. Whatever is common to the abstract traits of originality, fluency, and high motivational state may be operationally defined in terms of the explicated measures of originality and fluency as "creativity." The other measures listed in Table 12 represent indirect indicators of creativity. Thus, the highly creative person appears to be somewhat withdrawn, persistent in tasks, venturesome, and exploring. Originality, as indicated by the high factor loading, is the most dominant element of this factor.

Examining the second reformulation, shown in Table 13, three relatively independent factors appear to be descriptive of creativity. First, highly creative persons have strong tendencies to be original in the production of ideas and products. Coupled with originality is an ease of production (fluency) as well as a profusion of products (abundance). Additionally, certain non-cognitive traits appear related to the factor; the traits are assertiveness in the creative process and a willingness to take a chance and explore possibilities.

Table 12

An Outline of a Reformulation of the Construct of Creativity as a Single Factor of Creative Thinking[1]

Abstract Description of Component Traits	Measures of Factor IX Originality	Factor Loading
Originality	*Test of originality	.83
Fluency (Abundancy)	*Test of ideational fluency	.38
High Motivational State	*Factor E (Humble vs. Assertive)	.36
Radicalism	Factor H (Shy vs. Venturesome)	.32
	*Factor Q_1 (Conservative vs. Experimenting)	.39

[1]Those measures marked with an asterisk were originally hypothesized as related to creativity. The measure not marked was not hypothesized as related to creativity but now becomes part of the reformulated construct.

Table 13

An Outline of a Three-Factor Reformulation of the Construct of Creativity[1]

Abstract Description of Component Traits	Measures of	Factor Loading
I Factor of Creative Thinking	Factor IX Originality	
Originality	*Test of originality	.83
Fluency	*Test of ideational fluency	.38
High Motivational State	*Factor E (Humble vs. Assertive)	.36
	Factor H (Shy vs. Venturesome)	.32
Radicalism	Factor Q_1 (Conservative vs. Experimenting)	.39
II Personality Factor Related to Creativity	Factor XIV Creative Personality	
Reserve with People	*Factor A (Reserved vs. Outgoing	-.40
	Factor F (Sober vs. Happy-Go-Lucky)	-.60
	Factor H (Shy vs. Venturesome)	-.38
	*County Agricultural Agent	-.40
Radicalism	*Factor M (Prudent vs. Imaginative)	.39
	*Factor Q_1 (Conservative vs. Experimenting)	.34
	*Factor Q_2 (Group Dependent vs. Self-Sufficient)	.90
III Factor of Low Creative Persons' Interests	Factor IV Interests of Low Creative Persons	
Interests	*County Agricultural Agent	.40
	*Bank Cashier	.95
	Dentist	-.33
	*Interior Decorator	-.62
	*Architect	-.44

[1]Those measures marked with an asterisk were originally hypothesized as related to creativity. The measures not marked were not hypothesized as related to creativity but now become part of the reformulated construct.

The second factor is strictly a non-cognitive one and is focused on two clusters of traits, reserve with people and radicalism. Here, the highly creative person appears as socially withdrawn, shy, sober, and introspective. Correspondingly, there is a tendency for the highly creative person to have fanciful ideas, to explore and experiment, and to be independent. One conflict in this reformulation is the relation of the 16 PF trait H (Shy vs. Venturesome) to creativity. In the first factor, originality, trait H is shown as positively related to an aspect of creativity. In the second factor, personality traits, trait H is negatively related to creativity. At a conceptual level, the 16 PF scales are not necessarily mono-trait measures. Cattell uses a number of descriptive adjectives for each scale. As a result, it may well be that low scorers on trait H may be as highly creative as high scorers. Further, the regression of trai' H with some ultimate measure of creativity (for instance a true criterion measure) would be u-shaped.

The third factor is one of interests or preferences. And clearly, there are occupational distinctions to be drawn in terms of high and low creativity as related to these interest scales. Highly creative persons tend to have interests similar to those in occupations where products of the individual are prized (interior decorating, architecture, and writing) as opposed to occupations where service is rendered without palpable products (bank cashiers, accountants, and county agricultural agents).

Thus the second reformulation would permit a linear combination of three somewhat independent factors, and creativity would become a function of high scores in each of these three factors rather than a high score in any one. A person may have interests in common with creativity yet lack other essential cognitive and non-cognitive components which are necessary for creative production. Thus the multi-factor interpretation is dependent upon a variety of measures

across cognitive and affective domains.

A Final Comment

Certainly the continued study of the construct of creativity is important and worthwhile. Too frequently, current reviews of research on creativity have indicated a lack of construct validity without identifying the real problem as a lack of an explicitly formulated and testable construct. The pressing problem, therefore, is that creativity needs to be studied from a theoretical context. Several alternatives appear to confront those persons who are attempting a theoretical description of creativity. First, one might examine creativity in the context of historical figures who were creative geniuses (e.g. Ghiselin, 1952). The problem with this alternative is that the range of behavior exhibited is far too restricted and much like the situation where extremely gifted persons with high intelligence are solely studied to reveal the nature of human intelligence. Creativity has been conceptualized as a trait found to some degree in all persons. Focusing on a few persons who possess the trait to the highest degree limits the degree of generality of the conclusions. The second alternative is to define creativity in a construct and account for the evidence gathered in other studies (e.g. Cattell, Guilford). A third alternative is to attempt to validate the reformulated construct presented in this study. The central problem after devising a good theoretical description, regardless of which of the above alternatives is employed, will continue to be the development of reliable, efficient, and construct-valid measures. A final choice is to secure a mutually acceptable operational definition of creativity which can serve as a criterion measure, much in the spirit of Jackson and Messick (1965), who provided a theoretical framework for product assessment. The unfortunate aspect of these other criterion approaches is the failure to explicate and use such measures.

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Appendix A

Mean, Standard Deviation, Reliability Estimate, and Type of Distribution for All Variables

Variable	N	Mean	S.D.	Rel. Est.	Type of Distribution
Creative Thinking:					
*1. Ideational Fluency	769	20.4	7.2	.79	Normal
*2. Originality	768	32.5	13.9	.70	Platykurtic
*3. Semantic Redefinition	768	11.8	4.2	.67	Skewed Left
*4. Figural Adapt. Flexibility	763	14.4	5.6	.80	Normal
Spatial and Perceptual Abilities;					
1. Flexibility of Closure	763	29.9	21.0	.89	Platykurtic
2. Speed of Closure	768	44.2	28.5	.75	Normal
3. Length Estimation	770	33.5	7.6	.79	Normal
4. Perceptual Speed	770	77.7	17.1	.86	Skewed Left
5. Spatial Orientation	769	154.3	36.2	.85	Platykurtic
6. Spatial Scanning	768	24.0	16.8	.82	Skewed Left
7. Visualization	768	48.9	10.3	.85	Normal
8. Induction	769	63.9	25.3	.95	Multimodal**
16 PF Bipolar Traits:					
*1. A (Reserved vs. Outgoing)	744	7.4	4.8	.80	Normal
2. B (Less vs. More Intelligent	744	8.1	1.9	.42	Normal
3. C (Affected by Feeling vs. Emotionally Sensitive)	745	15.9	3.9	.66	Normal
*4. E (Humble vs. Assertive)	744	13.7	3.8	.65	Normal
5. F (Sober vs. Happy-Go-Lucky)	745	14.3	4.1	.74	Normal
6. G (Expedient vs. Conscientious)	744	12.0	3.3	.49	Normal
7. H (Shy vs. Venturesome)	743	12.2	4.8	.80	Normal
*8. I (Tough vs. Tenderminded)	741	7.4	3.0	.85	Skewed Right
9. L (Trusting vs. Suspicious)	744	8.7	3.1	.75	Normal
*10. M (Prudent vs. Imaginative)	744	11.0	3.4	.66	Normal

*Hypothesized as a measure of the construct of creativity.

** Observed by visual inspection of the distribution.

Appendix A--Continued

Variable	N	Mean	S.D.	Rel. Est.	Type of Distribution
16 PF Bipolar Traits (continued):	770				
*11. N (Forthright vs. Shrewd)	770	10.3	3.6	.35	Leptokurtic
12. O: (Placid vs. Apprehensive)	779	9.4	4.1	.70	Normal
*13. Q_1 (Conservative vs. Experimenting)	779	9.9	3.6	.50	Normal
*14. Q_2 (Group Dependent vs. Self-Sufficient)	779	10.1	3.9	.57	Normal
15. Q_3 (Casual vs. Controlled)	779	9.7	3.6	.36	Normal
16. Q_4 (Relaxed vs. Tense	779	10.9	4.8	.66	Normal
Kuder Scales:					
1. Personnel Manager	750	45.5	9.1	.90	Normal
2. High School Counselor	750	39.7	7.8	.90	Normal
3. YMCA Secretary	750	46.2	9.3	.88	Normal
4. School Superintendent	750	43.4	7.3	.75	Normal
5. High School Science Teacher	750	36.7	7.4	.90	Normal
*6. High School Math Teacher	750	34.7	6.3	.90	Normal
*7. Journalist	750	43.4	8.1	.88	Normal
*8. Newspaper Editor	750	29.8	7.6	.91	Normal
9. Lawyer	750	51.3	9.3	.90	Platykurtic
*10. Bank Cashier	750	43.6	7.2	.90	Normal
11. Retail Clothier	750	41.1	8.2	.90	Normal
*12. Accountant	750	44.7	7.6	.78	Normal
13. Dentist	750	41.5	6.7	.90	Normal
14. Physician	750	28.1	7.0	.79	Normal
15. Mining and Met. Engineer	750	38.6	6.3	.90	Leptokurtic
16. Civil Engineer	750	49.7	6.8	.86	Normal
*17. Interior Decorator	750	45.1	9.5	.90	Skewed Left
*18. Architect	750	65.5	11.0	.92	Skewed Left
*19. County Agricultural Agent	750	31.4	6.7	.88	Leptokurtic
*20. Forester	750	40.1	7.0	.82	Leptokurtic